Juniperus communis var. *kelleyi*, a new variety from North America

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ABSTRACT

Recent molecular analysis of *Juniperus communis*, world-wide (Adams and Schwarzbach, 2012), has shown that taxa referred to as *J. c.* var. *saxatilis* in the eastern hemisphere and in North America are not the same taxon, but are found in two distinct clades. The name is correctly applied to the taxon in the eastern hemisphere, but the taxon referred to as var. *saxitilis* in North America is given a new name: ***Juniperus communis* var. *kelleyi* R. P. Adams var. nov.** in honor of a former student, Walter A. Kelley. Leaf terpene data is presented for *J. c.* var. *kelleyi* and other *J. communis* varieties as well as *J. jackii*. The leaf oil of var. *kelleyi* is dominated by α-pinene (56.5%), δ-3-carene (11.5%) and β-pinene (5.4%) and is very similar to the oil of *J. c.* var. *depressa*. Published on-line **www.phytologia.org** *Phytologia 95(3): 215-221 (August 1, 2013).*

KEY WORDS: *Juniperus communis var. kelleyi* var. nov. **,** nomenclature, DNA, leaf terpenes.

Recently, Adams and Schwarzbach (2012) have shown that the North American taxon referred to as *Juniperus communis* var. *saxatilis* Pall. is not in the clade with *J. c.* var. *saxatilis* from Europe and Central Asia, but is actually most closely related to *J. c.* var. *depressa* from North America. To reflect these relationships, a new variety of *Juniperus communis* is described:

***Juniperus communis* var. *kelleyi* R. P. Adams, var. nov.** Fig. 1
Type: USA, Idaho, Blaine Co., on shore of Little Redfish Lake, 44° 09.588' N, 114° 54.372' W, 1997m, *Adams 10892* (HOLOTYPE: BAYLU).

Shrubs, similar to *J. communis* var. *depressa*, but differing in having curved to slightly curved leaves, with cross section concave and stomatal band 1.5- 2 x width of green leaf margins, leaf blades free, 30° to 80° to the stem, seed cones about as long as leaves, seed cones ovoid, seed cones purple-blue when mature.

Other specimens studied: TOPOTYPES: *Adams 10890, 10891, 10893, 10894* at BAYLU.

Juniperus communis var. *kelleyi* is common in the northwestern United States and B C, Canada (Fig. 2). In British Columbia and Alaska, var. *kelleyi* and var. *depressa* appear to intergrade.

The new variety is named in honor of my former student, Walter A. Kelley, Ph. D. 1976, Colorado State University. Walt passed away, unexpectedly with a heart attack in Costa Rica, Dec. 31, 2010, while on one of his many trips to the rainforest with his wife, Jan. Walt worked on isozymes of *Juniperus*. Photo (right) shows Walt collecting samples of *J. saltillensis* (Nuevo Leon, Mexico) on a trip with Tom A. Zanoni and RPA. Walt's keen interest in plants and sense of humor will be missed.

Figure 1. Holotype of *Juniperus communis* var. *kelleyi*, *Adams 10892*

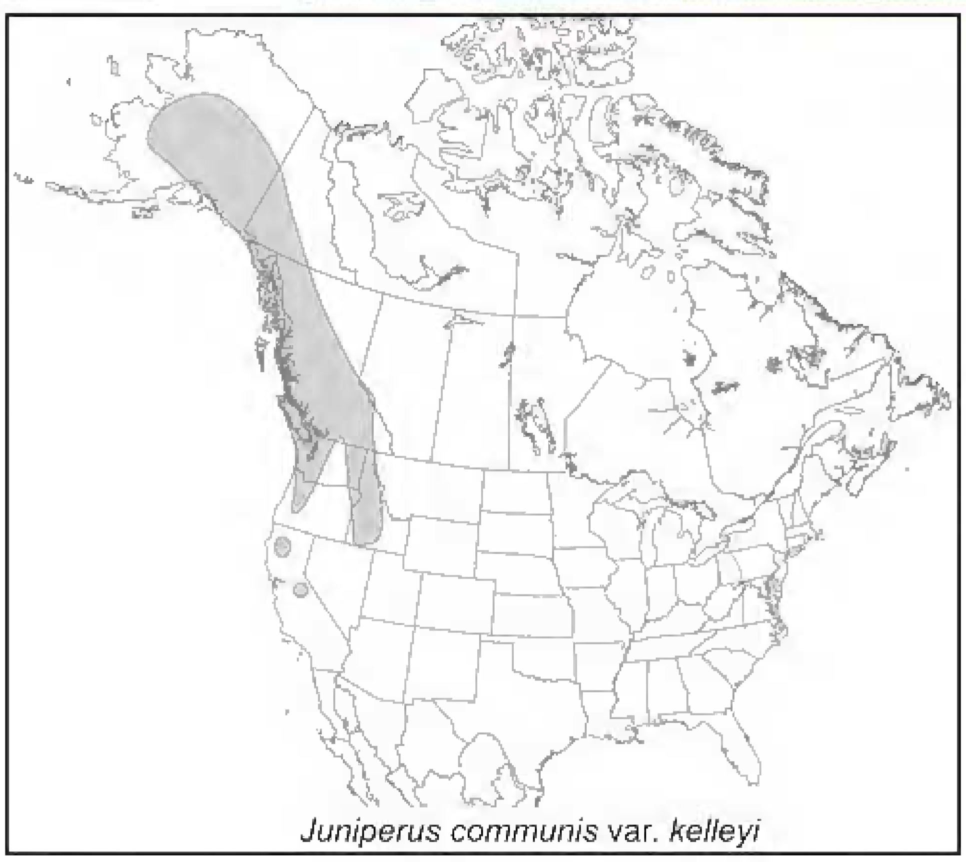

Figure 2. Distribution of *Juniperus communis* var. *kelleyi*.

Table 3. Comparison of the leaf morphology of *J. communis* var. *kelleyi*, *J. c.* var. *saxatilis* and *J. jackii*.

	J. c. var. *kelleyi*	*J. c.* var. *depressa*	*J. jackii*
Stomatal band width vs. green leaf margin (GM)	1.5 - 2x GM	1-1.5x GM	2-4x GM
Leaf cross-section	concave	very concave	concave,
Leaf shape	curved	straight	curved, boat shaped
Leaf blades	free, 30° to 80°	free, 45° to 20°	mostly appressed to stem
Mature seed cones vs. leaf length	cones about as long as leaves	cones much shorter than leaves	cones as long as or longer than leaves
Seed cone shape	ovoid	ovoid	elongated oval (ellisoid) esp. in immature cones

The phylogenetic position of *J. communis* var. *kelleyi* is shown in Figure 3, where it is in a clade with the other *J. communis* varieties from North America. The only other member of section *Juniperus* in North America is *J. jackii* that is in a clade with *J. mairei* from China (Fig. 3).

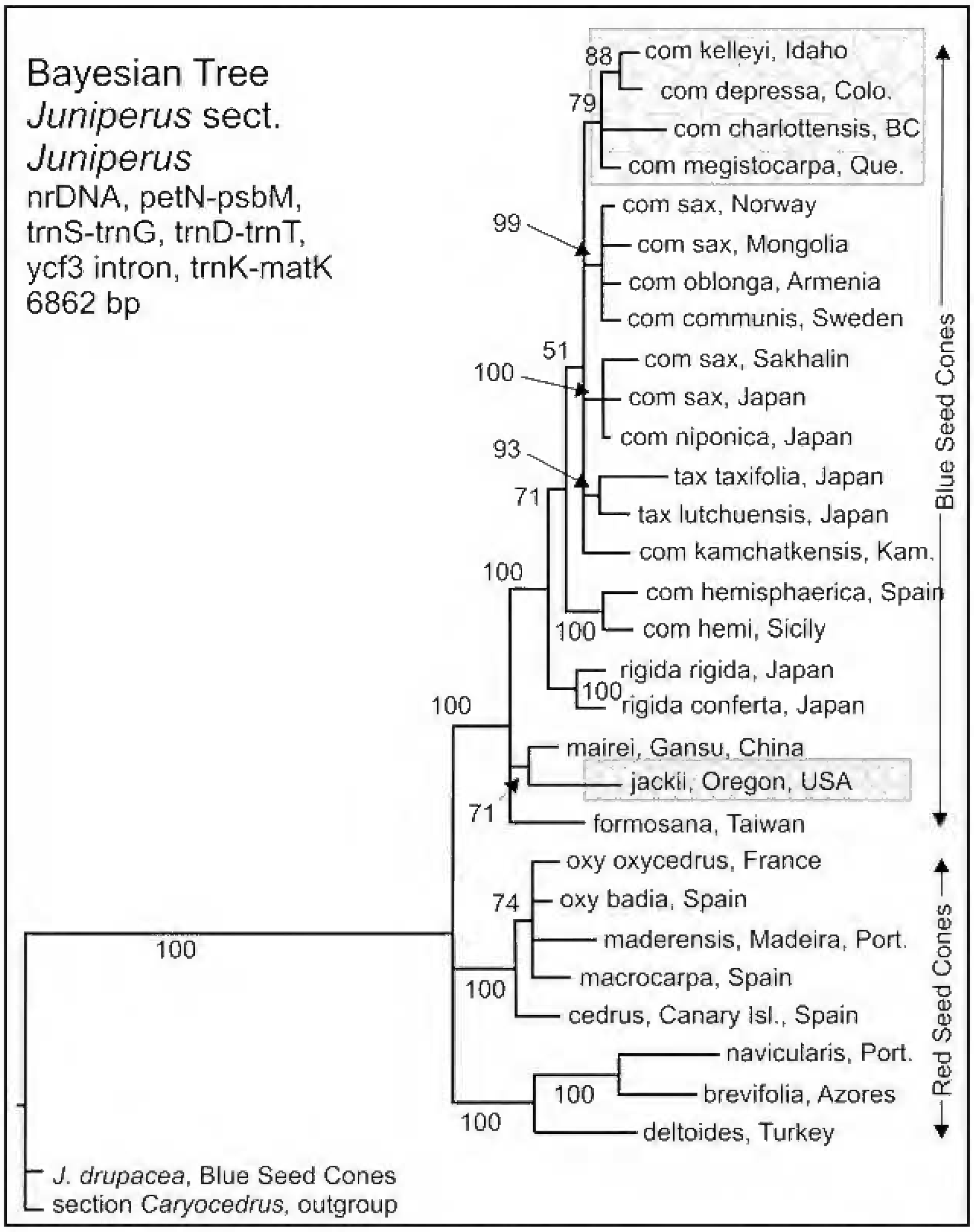

Figure 3. Bayesian tree for all taxa of *Juniperus* sect. *Juniperus* taxa. Numbers at the branch points are posterior probabilities (as percent). Adapted from Adams and Schwarzbach (2012).

A minimum spanning network of the taxa of section *Juniperus* shows that *J. communis* var. *kelleyi* differs by only 2 MEs (mutational events) from var. *depressa* (Fig. 4), but var. *kelleyi* is a number of MEs different from the *J. communis* complex in Europe and central Asia (Fig. 4).

A comparison of the leaf essential oil of var. *kelleyi* with var. *saxatilis* (Europe, Table 1) shows that these taxa differ in numerous components: α-pinene, sabinene, β-pinene, δ-3-carene, limonene, β-phellandrene, γ-terpinene, cis-sabinene hydrate, trans-sabinene hydrate, trans-thujone, terpinen-4-ol, myrtenol, citronellol, bornyl acetate, citronellyl acetate, neryl acetate, geranyl acetate, α-bisabolol, shyobunol, and 4 diterpenes. In fact, var. *saxatilis* (Europe, Table 1) seems to share a greater similarity in its oils with *J. jackii*, than with var. *kelleyi* (Table 1). The leaf oil of var. *kelleyi* is dominated by α-pinene (56.5%), δ-3-carene (11.5%) and β-pinene (5.4%) and is very similar to the oil of var. *depressa* (a similarity also seen in DNA sequence data, Figs. 3, 4).

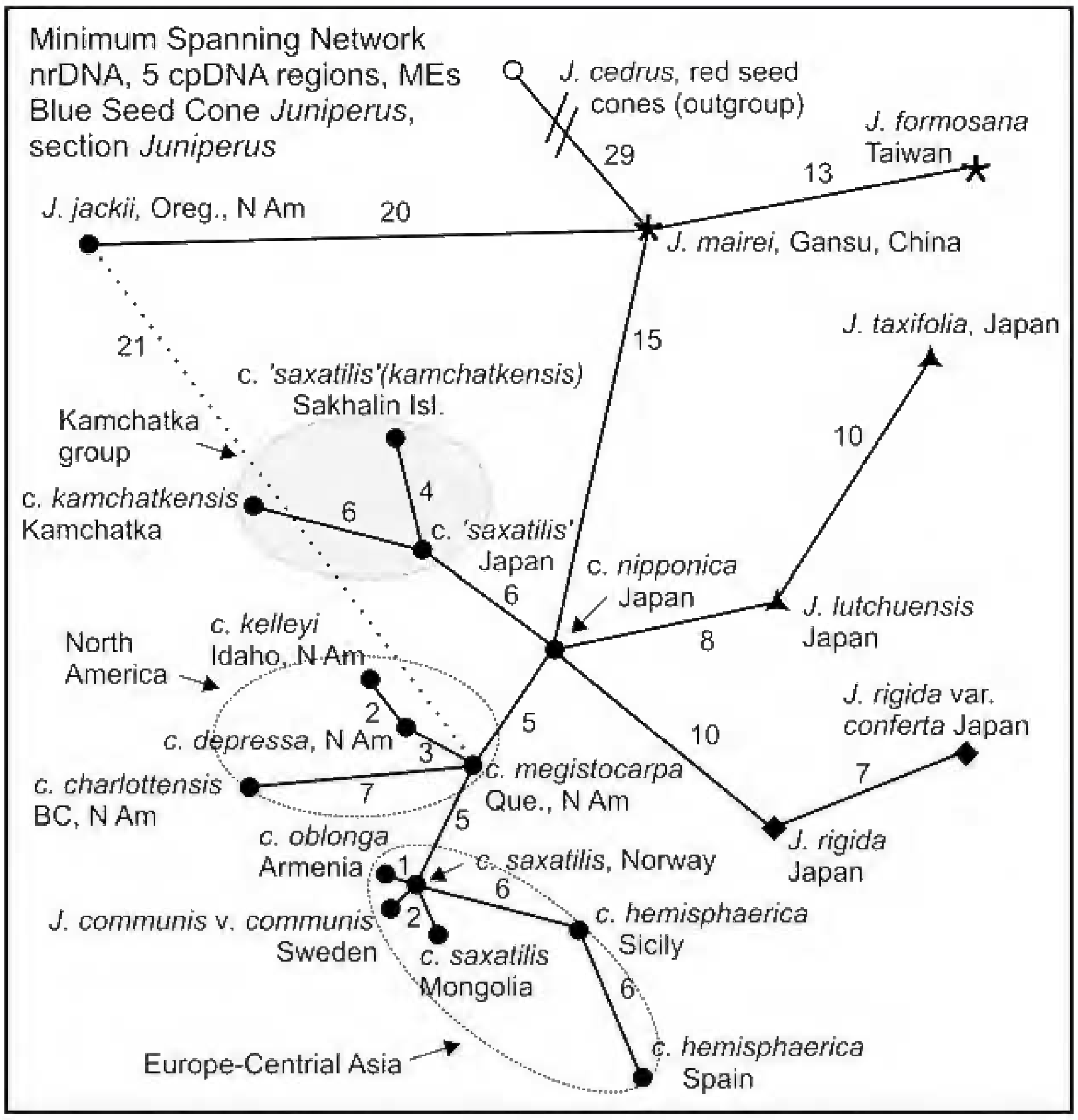

Figure 4. Minimum spanning network (MSN) of the blue seed cone junipers (see notes Fig. 4). *J. cedrus* is the nearest of the red seed cone species. Note that *c.* var. *kelleyi*, Idaho, North America is separated by only 2 MEs from *c. depressa* and is not in the group with *c. saxatilis* from Europe - Central Asia. Adapted from Adams and Schwarzbach (2012).

LITERATURE CITED

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Table 1. Comparison of the leaf oils of *J. communis* var. *kelleyi* with other varieties from North America and Europe and *J. jackii*. Taxa: *J. jackii* from serpentine, northwest California (jackii[1]) and lava, Mt Hood, n Oregon (*jackii*[2]); var. *charlottensis,* Queen Charlotte Island, BC (*char*); var. *depressa*, Guadalupita, NM (*dep*); var. *megistocarpa*, Magdalen Islands, Quebec (*meg*); var. *kelleyi* (Little Redfish Lake, ID); var. *saxatilis*, Switzerland, Europe (sax Eu); and var. *communis*, Stockholm, Sweden (com Sw). Data from Adams et al. (2010) and Adams (2000). Compounds in bold face appear to separate taxa.

		North America						Europe	
KI	Compound	*jackii*[1]	*jackii*[2]	*char*	*meg*	*dep*	*kelleyi*	*sax* Eu	*com* Sv
854	(E)-2-hexenal	0.2	1.0	0.4	0.1	0.1	0.3	1.2	0.7
926	tricyclene	t	t	0.1	0.1	0.1	0.1	t	0.3
931	α-thujene	t	t	t	t	t	t	4.1	0.1
939	**α-pinene**	**16.1**	**18.9**	**59.3**	**58.5**	**53.9**	**56.5**	**14.1**	**56.8**
953	α-fenchene	0.3	0.6	0.1	t	1.0	0.5	0.1	0.3
953	camphene	0.3	0.6	0.6	0.6	1.0	0.5	0.2	0.6
954	thuja-2,4-diene	-	-	0.1	-	0.1	-	-	-
967	**verbenene**	**0.3**	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**
976	**sabinene**	**0.1**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**32.8**	**0.7**
978	1-octen-3-ol	0.1	-	-	t	t	-	-	-
980	**β-pinene**	**1.9**	**1.9**	**5.9**	**5.0**	**5.5**	**5.4**	**1.9**	**4.4**
991	myrcene	3.2	3.2	4.8	3.9	4.1	4.5	5.0	5.2
997	**ethyl hexanoate**	**-**	**-**	**0.1**	**-**	**-**		**-**	**-**
1001	δ-2-carene	0.2	0.2	0.1	0.2	0.2	0.1	0.4	0.2
1005	α-phellandrene	2.2	2.5	0.1	0.1	0.2	0.1	0.5	2.1
1011	**δ-3-carene**	**17.9**	**28.4**	**3.6**	**0.7**	**9.3**	**11.5**	**0.5**	**4.7**
1018	α-terpinene	-	-	-	0.1	t	-	1.9	t
1026	p-cymene	1.1	0.8	0.2	0.1	0.2	t	0.3	0.3
1031	**limonene**	**6.6**	**0.5**	**1.9**	**20.4**	**2.6**	**2.1**	**6.7**	**5.1**
1031	**β-phellandrene**	**13.4**	**9.2**	**2.9**	**1.0**	**2.5**	**3.1**	**0.6**	**8.9**
1050	(E)-β-ocimene	0.3	t	-	t	t	-	0.1	0.1
1057	amyl isobutyrate	-	-	-	-	-	-	-	0.2
1062	**γ-terpinene**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**3.4**	**t**
1068	**cis-sabinene hydrate**	**-**	**-**	**-**	**t**	**-**	**t**	**1.8**	**t**
1088	**terpinolene**	**3.2**	**4.4**	**1.0**	**0.5**	**1.4**	**1.8**	**3.0**	**1.1**
1095	linalool	-	-	0.1	0.4	0.3	0.2	-	0.1
1097	trans-sabinene hydrate	-	-	-	-	-	-	1.3	-
1100	**n-nonanal**	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**
1103	isoamyl-isovalerate	-	-	-	-	-	-	t	0.1
1112	3-methyl-3-butenyl-								
	isovalerate	-	-	t	t	0.1	0.1	-	t
1114	trans-thujone (= β-thujone)	-	-	-	-	-	-	0.6	-
1121	cis-p-menth-2-en-1-ol	0.2	0.1	-	t	-	t	-	t
1125	α-campholenal	0.2	0.2	0.4	t	0.5	0.1	-	t
1132	cis-limonene oxide	0.1	0.4	-	0.2	0.2	-	-	-
1133	cis-p-mentha-2,8-dien-1-ol	-	-	-	-	-	0.1	-	-
1139	trans-pinocarveol	0.2	0.3	0.4	t	0.5	0.1	-	-
1141	camphor	-	-	0.2	-	-	0.2	-	-
1143	trans-verbenol	0.2	0.3	0.2	t	0.7	-	-	-
1147	3-methyl-2-butenyl-								
	isovalerate	-	-	-	-	0.1	0.2	-	t
1148	citronellal	-	-	-	0.2	0.2	0.1	-	-
1158	**pinocarvone**	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**
1159	p-mentha-1,5-dien-8-ol	0.4	0.3	0.3	-	0.5	0.1	-	t
1165	borneol	-	-	0.3	0.2	-	0.1	t	0.2
1172	cis-pinocamphone	-	-	0.1	-	-	0.1	-	-
1177	**terpinen-4-ol**	**0.7**	**0.3**	**0.5**	**0.2**	**0.5**	**0.3**	**7.3**	**0.2**
1176	m-cymen-8-ol	-	-	0.1	-	0.2	-	-	-
1179	naphthalene	-	-	0.1	0.2	-	-	0.3	t

KI	Compound	*jackii*[1]	*jackii*[2]	*char*	*meg*	*dep*	*kelleyi*	*sax* Eu	*com* Sv
1183	p-cymen-8-ol	0.3	0.3	0.1	-	0.2	-	t	t
1189	α-terpineol	0.3	0.3	1.0	1.5	0.6	0.5	0.4	0.2
1190	methyl salicylate	-	-	0.1	-	-	0.1	-	-
1194	myrtenol	0.4	0.3	0.3	0.5	0.5	0.3	-	-
1204	verbenone	0.3	0.5	0.3	-	0.3	t	-	t
1217	trans-carveol	0.4	t	0.3	t	0.2	t	-	-
1223	**citronellol**	**-**	**-**	**0.1**	**0.3**	**0.5**	**0.2**	**-**	**-**
1235	methyl thymol	0.2	0.2	-	t	-	0.1	0.1	-
1239	carvone	-	-	0.1	-	-	0.1	-	-
1249	piperitone	-	-	-	t	0.4	0.2	-	t
1257	methyl citronellate	-	-	0.2	t	0.1	0.3	-	t
1285	bornyl acetate	0.5	0.5	1.0	0.5	0.6	0.7	0.2	0.9
1291	trans-verbenyl acetate	-	-	-	t	-	-	-	-
1292	(E,Z)-2,4-decadienal	-	-	t	t	-	t	-	-
1293	methyl myrtenate	0.2	0.5	-	-	-	-	-	-
1302	**α-terpinyl formate**	**1.0**	**1.5**	**1.0**	**-**	**0.2**	**0.3**	**-**	**-**
1312	citronellic acid	-	-	-	t	t	t	-	-
1324	myrtenyl acetate	1.6	2.7	1.2	1.1	1.1	1.0	-	t
1332	cis-piperitol acetate	-	-	-	-	-	0.1	-	-
1365	cis-carvyl acetate	-	-	0.1	-	-	t	-	-
1350	α-terpinyl acetate	0.9	5.8	t	0.2	1.7	0.6	0.5	-
1350	**citronellyl acetate**	**-**	**-**	**0.1**	**t**	**0.3**	**0.1**	**-**	**t**
1359	**neryl acetate**	**-**	**-**	**0.1**	**t**	**0.1**	**0.1**	**-**	**-**
1379	**geranyl acetate**	**-**	**-**	**0.1**	**0.1**	**1.3**	**0.3**	**-**	**-**
1381	trans-myrtanyl acetate	t	t	-	-	-	-	t	-
1391	β-elemene	0.3	0.1	0.2	t	0.1	0.1	t	0.2
1418	(E)-caryophyllene	0.4	t	t	-	-	0.1	t	0.7
1448	**cis-muurola-3,5-diene**	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**
1454	α-humulene	0.5	0.2	0.1	-	t	0.1	t	0.5
1465	cis-muurola-4(14),5-diene	t	t	0.1	-	-	-	-	-
1475	trans-cadina-1(6),4-diene	-	-	0.1	-	-	0.1	-	-
1477	γ-muurolene	t	t	0.1	t	0.1	0.1	t	t
1480	germacrene D	4.1	1.1	0.3	0.1	0.2	0.6	0.4	0.7
1493	trans-muurola-4(14),5-dier	-	-	0.1	-	-	0.1	-	-
1493	epi-cubebol	0.3	t	0.2	-	-	-	-	t
1499	α-muurolene	0.6	0.2	0.3	0.1	0.1	0.2	0.2	0.2
1503	germacrene A	t	t	0.1	t	0.1	0.1	0.2	0.1
1505	**β-bisabolene**	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**
1513	γ-cadinene	1.2	0.4	0.4	0.1	0.2	0.3	0.4	0.2
1524	δ-cadinene	2.2	0.7	1.4	0.4	0.5	0.7	0.8	0.5
1538	α-cadinene	0.2	0.1	0.1	t	0.1	0.1	t	t
1549	elemol	t	-	-	-	t	t	-	t
1556	**germacrene B**	**0.5**	**0.3**	**0.3**	**-**	**0.3**	**1.2**	**0.3**	**0.3**
1561	(E)-nerolidol	-	-	t	0.1	t	t	-	-
1574	germacrene D-4-ol	0.9	0.8	0.8	0.5	1.0	1.2	1.8	0.8
1577	spathulenol	-	-	0.1	0.1	-	0.1	-	t
1607	β-oplopenone	-	-	0.1	t	-	0.1	-	-
1581	caryophyllene oxide	0.2	t	-	-	-	-	-	t
1594	salvial-4(14)-en-1-one	0.1	-	-	-	-	-	-	-
1606	humulene epoxide II	t	t	-	-	0.1	-	-	t
1627	1-epi-cubenol	1.5	t	t	-	-	t	t	t
1640	epi-α-cadinol	0.7	0.3	0.3	0.1	0.2	0.2	0.5	t
1640	epi-α-muurolol	0.8	0.3	0.3	0.1	0.2	0.3	0.5	0.4
1645	α-muurolol	0.4	0.1	0.1	t	0.1	0.1	0.1	t
1653	α-cadinol	2.0	1.1	0.9	0.3	0.7	0.8	1.3	0.5
1685	**α-bisabolol**	**-**	**-**	**1.0**	**t**	**0.7**	**0.2**	**-**	**-**
1685	germacra-4(15),5,10(14)-								
	trien-1-al	0.3	-	-	-	-	-	-	t
1688	shyobunol	t	t	0.2	-	0.1	0.3	-	0.7

KI	Compound	*jackii*[1]	*jackii*[2]	*char*	*meg*	*dep*	*kelleyi*	*sax* Eu	*com* Sw
1714	**(2E,6Z)-farnesal**	**-**	**-**	**-**	**t**	**-**	**-**	**-**	**-**
1722	**(2Z,6E)-farnesal**	**-**	**-**	**-**	**0.3**	**-**	**-**	**-**	**-**
1742	**(2E,6E)-farnesal**	**-**	**-**	**-**	**t**	**-**	**-**	**-**	**-**
1806	**nootkatone**	**-**	**-**	**0.1**	**-**	**-**	**-**	**-**	**-**
1933	cyclohexadecanolide	0.1	-	0.1	-	-	-	-	-
1968	sandaracopimara-8(14), 15-diene	-	t	-	-	-	-	-	-
2022	abieta-8,12-diene	-	t	-	-	-	-	-	-
1989	**manoyl oxide**	**0.2**	**0.3**	**-**	**-**	**-**	-	**0.1**	**-**
2055	**abietatriene**	**0.3**	**0.6**	**0.1**	**-**	**-**	-	**0.2**	**-**
2056	**manool**	**0.6**	**0.7**	**-**	**-**	**-**	-	**-**	**-**
2080	**abietadiene**	**-**	**1.1**	**-**	**-**	**-**	-	**0.4**	**-**
2106	**isoabienol**	**0.2**	**0.9**	**-**	**-**	**-**	-	**0.1**	**-**
2331	**trans-ferruginol**	**t**	**0.2**	**-**	**-**	**-**	-	**-**	**-**

KI = Kovat's Index on DB-5(= SE54) column. *Tentatively identified. Compositional values less than 0.1% are denoted as traces (t). Unidentified components less than 0.5% are not reported.